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RETURN-VOLATILITY SPILLOVER AND FOREIGN OPERATIONS OF DUALLY-LISTED GLOBAL FIRMS*

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Abstract

This paper investigates the pricing spillovers between the local (Asian, European, and Oceanian) market and the U.S. market by using daytime and overnight returns on 114 Asian, European, and Oceanian underlying stocks and their ADRs. We have found that the return and volatility spillover from the underlying stock in the daytime local markets to its ADR in the overnight U.S. market is much stronger than the return and volatility spillover effect in the reverse direction from the U.S. market to the local markets. We have also found that, in Korea and Japan, the Asian financial crisis has further intensified the spillovers in both directions from the local market to the U.S. market and from the U.S. market to the local market. The return and volatility spillover is related with the extent of foreign operations of the firms. That is, the more the foreign operations (in terms of sales and assets), the more the return spillover from the U.S. market to the local market, but the less the return spillover in the opposite direction.

Keywords: information transmission, ADRs, underlying stocks, returns, volatility, Asian financial crisis, GARCH
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I. *Introduction*

The globalization of the world economy and the integration of the world financial markets are the main themes of the current era.[1] In accordance with the trends, companies from all over the world, especially multinational corporations, have cross-listed their stocks on their local and major international stock exchanges. For example, the New York Stock Exchange (NYSE) and NASDAQ have attracted many foreign companies mainly due to their high liquidity and large investor base, which in turn issue their shares in the form of American Depositary Receipts (ADRs). Along with underlying stocks listed on their local stock exchanges, ADRs become another investment vehicle, especially for U.S. domestic investors.

International finance literature looks into the interdependence or information transmission between international stock markets.[2] Hamao, Masulis, and Ng (1990) study the short-run interdependence of prices and price volatility across three major international stock markets using daily opening and closing prices of the major stock indexes for the Tokyo, London, and New York stock markets. They find evidence of price volatility spillovers from New York to Tokyo, London to Tokyo, and New York to London, but no price volatility spillover effects in other directions for the pre-October 1987 period. In contrast, Lin, Engle, and Ito (1994) find that cross-market interdependence in returns and volatilities is generally bi-directional between the New York and Tokyo markets.[3] Ng (2000) finds volatility spillover from Japan and the U.S. to the Pacific-Basin countries, and Baele (2005) also finds that the shock spillover between European countries and the U.S. is significant, and the spillover intensity is time-varying.

Recent literature also shows mixed empirical results about market integration. Hauser, Tanchuma, and Yaari (1998) examine five companies based in Israel whose stocks are listed on both the Tel Aviv Stock Exchange and NASDAQ.[4] Their results show that price causality in dually listed stocks is unidirectional from the domestic market to the foreign market. Niarchos, Tse, Wu, and Young (1999) investigate the international information transmission between the U.S. and Greek stock markets using daily data from the Athens Stock Exchange and the S&P 500 Index returns, but find no spillovers between these two markets for the conditional mean and variance. Also, their cointegration test shows that these two markets are not driven by a common trend. It appears that the U.S. and Greek stock markets are not related to each other, either in the short-run or in the long-run. The evidence shows that the U.S. market does not have a strong influence on the Greek stock market.

On the other hand, Hong Kong- and China-based stocks show significant information

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[1] See Bekaert, Harvey, and Ng (2005).

[2] Other international finance literature on global financial market integration and cross-listings has dealt with several issues including the relationships between market integration and cost of capital and between investor recognition and cost of capital. For example, Merton (1987) suggests that the increase in measure of investor recognition associated with international cross-listing should be associated with reduction in a firm's cost of capital. With regard to this issue, numerous studies look into an abnormal return behavior around cross-listing and find lower returns associated with lower risk.

[3] Lau and Diltz (1994) also studied the transmission of pricing information between New York and Tokyo exchanges using seven Japanese stocks.

[4] Liberman, Ben-Zion, and Hauser (1999) also investigated the information transmission using dually-listed stocks on the OTC in the U.S. and on the Tel Aviv Stock Exchange.

transmission phenomena between local and remote stock exchanges. For example, Xu and Fung (2000) examine the patterns of information flows for China-backed stocks that are cross-listed on exchanges in Hong Kong and New York. Their results indicate significant mutual feedback of information between domestic and offshore markets in terms of pricing and volatility. Stocks listed on the domestic market appear to play a more significant role of information transmission in the pricing process, whereas stocks listed on the offshore market play a bigger role in volatility spillover. Yeh and Lee (2000) investigate the response of investors to unexpected returns and the information transmission in the stock markets of the Greater China area, and find that the impact of bad news on future volatility is greater than the impact of good news on future volatility of the same magnitude in the Taiwan and Hong Kong markets, while the opposite was found in the Shanghai and Shenzhen markets. They also show that the Hong Kong stock market plays a most influential role among the Taiwan, Shanghai and Shenzhen B-share stock markets. Wang, Rui, and Firth (2002) provide evidence of returns and volatility spillovers in bi-direction from Hong Kong to London and from London to Hong Kong by using Hong Kong stocks dually-traded on the Hong Kong and London Stock Exchanges.

Recently, the futures market literature has also looked into information transmission between international futures markets. Tse (1998) also examines the information transmission between the Japan and U.S. markets by using the Tokyo Euroyen and Chicago Eurodollar futures. These two interest rate futures markets provide a better understanding of international information transmission than do stock markets, since they have been shown to exhibit nonsynchronous trading and market segmentation. He shows that unexpected foreign daytime interest change contemporaneously influence domestic overnight changes, but there is no evidence of lagged volatility spillovers in either direction, suggesting that the opening price rapidly and efficiently reflects foreign information arrived overnight. His overall results support the hypothesis that the domestic market efficiently adjusts to foreign news. Fung, Leung, and Xu (2001) examine the patterns of information flows for three financial futures contracts that are dual-listed on the U.S. and Asian markets. They find that the U.S. market plays a leading role in all the futures markets in transmitting pricing information and that their results do not support the home-bias hypothesis that home information should be dominant in information transmission. They also find that foreign markets seem to play a relatively more important role in volatility spillover, implying that volatility information is coming primarily from offshore markets.

This paper investigates the pricing information transmission or return/volatility spillover between the local Asian or European market and the U.S. market by using the sample of major multinational Asian and European firms. We also examine the relation between the extent of return-volatility spillover and the firm characteristics, especially, the foreign operations. Our study differs from the existing literature in several ways. First, this study is quite an extension of the previous studies investigating the pricing information transmission between ADRs and underlying stocks issued by Asian and European firms with respect to the sample period, number of firms, and methodology. Secondly, this is the first paper to examine if the degree of foreign operations of Asian or European firms affects the extent of return/volatility spillover between the underlying stocks and their ADRs. Thirdly, our methodology can test the difference in the information transmission (or the unexpected return and volatility spillover effect) between after and before the Asian financial crisis, especially for the Asian firms. In fact, the ADRs of Asian underlying firms are useful to examine the pure effect of the information transmission, since the Asian and U.S. trading hours do not overlap in time at all. Fourthly, we use the two daily stock returns — open-to-close (daytime) returns and close-to-open (overnight) returns — of individual firms instead of using the market index returns or close-to-close returns of individual firms as in most previous studies.

The organization of this paper is as follows. Section II presents data and variable description, and Section III introduces the econometric model. Section IV presents the empirical findings along with the discussions. Section V concludes.

II. *Data*

Our sample includes forty Asian firms whose ADRs are actively traded in the NYSE and NASDAQ. They are 27 Asian firms (3 Korean, 15 Japanese, 3 Hong Kong, 3 Chinese, 2 Taiwanese, and 1 Philippine firms), 13 Oceanian firms (11 Australian, and 2 New Zealand firms), 74 European firms (23 U.K., 15 French, 11 German, 7 Italian, 5 Finnish, 7 Swiss, 3 Swedish, 1 Spanish, 1 Norwegian, 1 Belgian firms). Table 1 provides the complete list of the Asian and European sample firms. Daily opening and closing prices for the underlying stocks and their ADRs are used in this paper. The main database is Thomson Financial's Datastream for the underlying stock prices, and the Yahoo website for ADR prices. Yearly data of the total assets invested in foreign countries and foreign sales, market-to-book ratios, and firm size are obtained from Datastream. Our sample period starts from as early as the beginning of 1990 and ends October 2002.

We divide daily (close-to-close) returns of each underlying stock into overnight (previous close-to-open) returns and daytime (open-to-close) returns. They are all continuously compounded returns and are defined as follows:

$R_{N,\,t}$ = overnight return on the underlying stock in a local market = $\ln(O_t/C_{t-1})$
$R_{D,\,t}$ = daytime return on the underlying stock in a local market = $\ln(C_t/O_t)$,

where

O_t = opening price at day t in Local Standard Time
C_t = closing price at day t in Local Standard Time

The overnight and daytime returns on the ADR are defined in a similar way. That is,

$R^A_{N,\,t}$ = overnight return on the ADR in the U.S. markets = $\ln(O^A_t/C^A_{t-1})$
$R^A_{D,\,t}$ = daytime return on the ADR in the U.S. markets = $\ln(C^A_t/O^A_t)$,

where

O^A_t = opening price at day t in U.S. Eastern Standard Time
C^A_t = closing price at day t in U.S. Eastern Standard Time.

Although we do not report the results for the basic statistics (mean return, standard deviation, skewness, kurtosis, Ljung-Box Q(12) statistic) of daytime returns and overnight returns of all the underling stocks and their ADRs because of space, we discuss some interest results.[5]

It is noteworthy that for most of the underlying stocks, daytime returns are more volatile (measured by standard deviation) than overnight returns. On the other hand, for most of their ADRs, overnight returns are more volatile than daytime returns. The reason is that the relevant firm-specific information more often arrives to the local daytime Asian market and then immediately to the U.S. overnight market. These results are consistent with Wang, Rui, and Firth's (2002) results using Hong Kong stocks. Given that information and trading noise have been verified as important determinants of stock return volatilities, the results suggest that local daytime information is more influential than U.S. daytime information on the pricing of dually-traded stocks in the local Asian and the U.S. markets.

Another interesting finding is that the Asian emerging market stock volatility is overall higher than the developed market volatility. The underlying stock daytime return volatility of the non-Japanese Asian firms is mostly greater than that of the Japanese and European firms. As for the skewness, it is usually positive and indicates the upside potential of Asian firms in the most rapidly growing economic region. Most of the underlying stocks and their ADRs have the excess kurtosis much greater than the upper 1 percentile point of 0.13, indicating that they have significantly fatter tails than the stationary normal distribution. In particular, the kurtosis of the overnight returns is much greater than that of the daytime returns. This implies that more frequent regime changes in volatility have occurred in the overnight returns than in the daytime returns.

The test results show that all the sample firms have serial dependence in return data. The Ljung-Box Q(12) statistic for the cumulative effect of up to twelve order autocorrelation in the returns exceeds 26.22 (the one percentile critical value from a Chi-square distribution with 12 degrees of freedom) for all the sample firms. The Ljung-Box Q(12) statistic on the squared returns provides us with a test of intertemporal dependence in the variance. The statistics for all the sample firms also reject the zero correlation null hypothesis of the squared returns. That is, the distribution of the next (squared) return depends not only on the (squared) current return, but on several previous returns. These results indicate that most of the return series show conditional heteroskedasticity so that the use of a GARCH model is justified in modeling the overnight and daytime return series.

III. *The Basic Model*

Kim and Kon (1994) reports that among the intertemporal dependence models, Glosten, Jagannathan, and Runkle's (GJR) (1993) model is the most descriptive for individual stocks. Therefore, in order to investigate the short-run interdependence of returns and return volatilities of the underlying stock and its ADR traded on the local market and the U.S. market, we employ the GJR model with several exogenous variables in the mean and variance equations. That is, for an underlying stock,

$$
\begin{aligned}
R_{N,t} &= \lambda_0 + \lambda_1 R_{D,t-1} + \phi \hat{e}^{A}_{D,t-1} + \theta_1 h_{N,t} + \varepsilon_{N,t} - a_1 \varepsilon_{N,t-1} \\
h_{N,t} &= \alpha_0 + \alpha_1 \varepsilon^2_{N,t-1} + \beta_1 h_{N,t-1} + \gamma_1 S^{-}_{t-1} \varepsilon^2_{N,t-1} + \delta \hat{e}^{A\,2}_{D,t-1}
\end{aligned}
\tag{1}
$$

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[5] The results are available upon request.

where

$\hat{e}^{A}_{D,t-1}$ = residual (unexpected) return on the ADR traded in NY daytime which is estimated from a separate model
$h_{N,t}$ = conditional variance of the underlying stock's local overnight return
$S^{-}_{t-1}=1$ if $\varepsilon_{N,t-1}$ is negative and 0 otherwise.

The above model is in fact GJR(1,1)-M with the MA(1) error term and two exogenous variables ($R_{D,t-1}$ and $\hat{e}^{A}_{D,t-1}$) in the mean equation and with one exogenous variable ($\hat{e}^{A\,2}_{D,t-1}$) in the variance equation. The method of generating the residual returns is to be explained in the later part of this section. The MA(1) term is necessary in order to capture the intertemporal correlation of the error terms. The term S^{-}_{t-1} in the model (1) allows the impact of the squared residual on conditional volatility to be different when the lagged one residual is negative than when the lagged one residual is positive. Therefore, the asymmetry response (or the leverage effect) in conditional variance to past positive and negative innovations is captured with the hypothesis that $\gamma_1>0$. Note that since all(almost all) of the daytime trading hours at day $t-1$ in the U.S market are overlapped with the overnight hours at day t in the Asian(European) markets, the time subscript t in the overnight return variable of the underlying stock traded in a local market (as in $R_{N,t}$) is contemporaneous with the time subscript $t-1$ in the daytime return of the ADR traded in the U.S. market (as in $\hat{e}_{D,t-1}$).

The model for its counterpart ADR is similarly constructed as follows:

$$\begin{aligned} R^{A}_{N,t}&=\lambda^{A}_{0}+\lambda^{A}_{1}R^{A}_{D,t-1}+\phi^{A}\hat{e}_{D,t}+\theta^{A}_{1}h^{A}_{N,t}+\varepsilon^{A}_{N,t}-a^{A}_{1}\varepsilon^{A}_{N,t-1} \\ h^{A}_{N,t}&=\alpha^{A}_{0}+\alpha^{A}_{1}\varepsilon^{A\,2}_{N,t-1}+\beta^{A}_{1}h^{A}_{N,t-1}+\gamma^{A}_{1}S^{-}_{t-1}\varepsilon^{A\,2}_{N,t-1}+\delta^{A}\hat{e}^{2}_{D,t} \end{aligned} \quad (2)$$

where

$\hat{e}_{D,t}$ = residual (unexpected) return on the underlying stock traded in a local market daytime which is estimated from a separate model.

Note that the superscript 'A' in the variables and parameters indicates 'ADR'. Note also that since all of the daytime trading hours at day t in a local Asian market are overlapped with the overnight hours at day t in the U.S. market, the time subscript t in the overnight return variable of the ADR traded in the U.S. market (as in $R^{A}_{N,t}$) is contemporaneous with the time subscript t in the daytime return of the underlying stock traded in a local Asian market (as in $\hat{e}^{A}_{D,t}$). In the case of European firms, however, the local daytime hours at day t are overlapped with both the daytime and overnight hours at day in the U.S. market. For example, the London time is 5 hours ahead of the New York time. So, when the London Stock Exchange closes at 4:30 p.m. in London time, the New York Stock Exchange has already opened for 2 hours. Considering that the more information comes for 5 and half hours after the London market closes and before the New York market closes, than for 2 hours before the London market closes, the conclusion may not be different despite overlapping daytime trading hours.

It is worthwhile to note that the above equations (1) and (2) are the model with generated regressors. That is, these models have residuals, $\hat{e}^{A}_{D,t-1}$ or $\hat{e}_{D,t}$, as regressors.
Since we use the full information maximum likelihood estimation for these models, our inferences based on this estimation technique are valid. According to Pagan (1984), the estimators in this case are consistent, but inefficient. However, the inferences based on the standard errors from the maximum likelihood estimator are valid.

The key parameters in the above models of equations (1) and (2) are ϕ and δ for the hypothesis test of the contemporaneous information transmission from the U.S. market to a local Asian or European market and ϕ^A and δ^A from a local market to the U.S. market. The parameter $\phi(\delta)$ measures the sensitivity of the unexpected daytime return (volatility) surprise of an ADR during the opened U.S. market to the overnight return (volatility) of its underlying stock during a closed local market. On the other hand, the parameter $\phi^A(\delta^A)$ indicates the sensitivity of the unexpected daytime return (volatility) surprise of an underlying stock during an opened local market to the overnight return (volatility) of its ADR during the closed U.S. market.

The coefficient $\lambda_1(\lambda_1^A)$ captures the correlation between the overnight return and the one-period lagged daytime return of the underlying stock (ADR) traded in a local market (the U.S. market). $\theta_1(\theta_1^A)$ measures the overnight risk premium on the underlying stock (ADR) and is expected to be positive.

The unexpected return on the ADR ($\hat{e}^A_{D,t}$) is first estimated from the following model and then is used as an exogenous variable in the main model of equation (1):

$$\begin{aligned} R^A_{D,t} &= \lambda^A_0 + \lambda^A_1 R^A_{N,t} + \gamma^A_2 R^A_{m,t} + \theta^A_1 h^A_{D,t} + e^A_{D,t} - a^A_1 e^A_{D,t-1} \\ h^A_{D,t} &= \alpha^A_0 + \alpha^A_1 e^{A\,2}_{D,t-1} + \beta^A_1 h^A_{D,t-1} + \gamma^A_1 S^-_{t-1} e^{A\,2}_{D,t-1} \end{aligned} \tag{3}$$

where $R^A_{m,t}$ is the close-to-close return on the U.S. market index. We use the Standard and Poor's 500 Index as a proxy for the U.S. market index. The residuals are regarded as the unexpected returns on the ADR after adjusting for its overnight return and for the market. The above model is the GJR model similar to equations (1) and (2). The unexpected return on the underlying stock ($\hat{e}_{D,t}$) is also similarly estimated from the following model:

$$\begin{aligned} R_{D,t} &= \lambda_0 + \lambda_1 R_{N,t} + \lambda_2 R_{m,t} + \theta_1 h_{D,t} + e_{D,t} - a_1 e_{D,t-1} \\ h_{D,t} &= \alpha_0 + \alpha_1 e^2_{D,t-1} + \beta_1 h_{D,t-1} + \gamma_1 S^-_{t-1} e^2_{D,t-1} \end{aligned} \tag{4}$$

where $R_{m,t}$ is the close-to-close return on a local market index.

In order to examine the relation between the return-volatility spillover and the foreign operations, we estimate the second-pass cross-sectional regression model. After estimating the degree of information transmission of return (ϕ, ϕ^A) and of volatility (δ, δ^A) for all firms in the first-pass, we cross-sectionally regress year-by-year the estimates of return (or volatility) information transmission coefficient on foreign operation variables such as foreign assets and foreign sales. This is similar to Fama and MacBeth (1973) two-pass methodology. In order to control for risk, we include market-to-book ratio, firm size, and market beta as the controlling variables for risk. Specifically, for year t,

$$\begin{aligned} IT_{it} = {} & b_{0t} + b_{1t} FA_{it} + b_{2t} DFA_{it} + b_{3t} FS_{it} + b_{4t} DFS_{it} + b_{5t} MB_{it} + b_{6t} DMB_{it} + b_{7t} MV_{it} \\ & + b_{8t} \hat{\beta}_{it} + \varepsilon_{it}, \qquad i = 1, \cdots, N_t \end{aligned} \tag{5}$$

where

IT_{it} = estimates of information transmission coefficient of firm i at year t ($\hat{\phi}_i$ or $\hat{\phi}^A_i$ for return information transmission and $\hat{\delta}_i$ or $\hat{\delta}^A_i$ for volatility information transmission)

FA_{it} = foreign assets of firm i at year t divided by its total assets if the data is available and 0 otherwise

DFA_{it} = dummy variable; 0 if FA_{it} data is available and 1 otherwise
FS_{it} = foreign sales of firm i at year t divided by its total assets if the data is available and 0 otherwise
DFS_{it} = dummy variable; 0 if FS_{it} data is available and 1 otherwise
MB_{it} = market-to-book equity ratio of firm i at year t if the data is available and 0 otherwise
DMB_{it} = dummy variable; 0 if MB_{it} data is available and 1 otherwise
MV_{it} = log(market capitalization) of firm i at year t
$\hat{\beta}_{it}$ = Scholes-Williams(1977) beta estimate of firm i at year t
N_t = number of firms at year t

The final estimates are the time-series averages of each coefficient estimates in equation (5) and their standard errors are obtained from the times-series of the coefficient estimates.

IV. *Empirical Results*

1. Estimation Results of Return-Volatility Spillovers

Table 1 presents the estimation results of model (1). Most of the estimated coefficient, $\hat{\phi}$, the estimate of the unexpected return spillover effect from the U.S. market to the local market, are positive with a statistical significance at one or five percent level.[6] This indicates that the (market-adjusted) unexpected return on an ADR in the U.S. market has a positive impact on the overnight return on its underlying stock in the local market. This phenomenon is observed in all countries considered. Note, however, that European companies have a smaller degree of the return spillover effect from the U.S. market to the local market than do the other countries' companies. For example, 26 among the 27 Asian firms and 10 among the 13 Oceanian firms have positive significant estimates of the return spillover effect coefficient, ϕ, while only 41 among the 74 European firms do. Especially, except for Telecom Italia, all Italian firms have insignificant estimates of the return spillover effect coefficient. The UK firms have relatively stronger return spillover effect than the other European firms. The average estimated values of the return spillover coefficient, $\bar{\hat{\phi}}$, of the Asian, Oceanian, and European firms are 0.149, 0.117, and 0.088, respectively.

Almost all of the coefficient estimates of the volatility spillover effect from the U.S. market to the local market via ADR, $\hat{\delta}$, are also statistically positively significant at one percent level (all 27 Asian firms, 11 among the 13 Oceanian firms, and 66 among the 74 European firms). The extent of volatility spillover is greater than that of return spillover, since the statistical significance (not reported) of $\hat{\delta}$ is much stronger than that of $\hat{\phi}$. One thing to be noteworthy is that the volatility spillover effect is strongest in European firms, while the return spillover effect is weakest in European firms. The average estimated values of the volatility spillover coefficient, $\bar{\hat{\delta}}$, of the Asian, Oceanian, and European firms are 0.080, 0.059, and 0.099, respectively.

Table 2 shows the return and volatility spillover effect in the reverse direction from the local market to the U.S. market. The parameter ϕ^A (δ^A) is the coefficient of the market-adjusted unexpected daytime return (volatility) of the underlying stock on the overnight return

[6] All returns are measured based on local currencies.

(volatility) of its ADR. Thus, this coefficient measures an unexpected return (or volatility) spillover effect from the local market to the U.S. market. All 27 Asian firms, 11 among 13 Oceanian firms, and 73 among 74 European firms have positively significant estimates of the return spillover effect coefficient from the local market to the US market, ϕ^A. The average estimated values of the return spillover coefficient, $\bar{\hat{\phi}}^A$, of the Asian, Oceanian, and European firms are 0.513, 0.443, and 0.539, respectively.

The estimate of the return spillover coefficient, $\hat{\phi}^A$, is much greater in magnitude and in statistical significance than the estimate of the return spillover coefficient in the opposite direction, $\hat{\phi}$, in Table 1. More specifically, the return spillover from the underlying stock in the local market to its ADR in the U.S. market during the overnight hours is much greater than the return spillover effect in the reverse direction. For example, in the case of Korea Electric Power, the unexpected increase of the underlying stock return by 1 percent could cause the increase of the ADR return by 0.385 percent, while the unexpected increase of the ADR return by 1 percent could cause the increase of the underlying stock return only by 0.086 percent. The former spillover effect is at least four times greater than the latter spillover effect. In fact, these results are consistent with the results from the cross-correlation coefficients between the daytime returns and the overnight returns of the underlying stocks and their ADRs (not reported).[7] The cross-correlation coefficients between the underlying daytime returns and the ADR overnight returns are greater than those between the underlying overnight returns and the ADR daytime returns.

Table 2 also shows that the volatility spillover effect from the local market to the U.S. market overnight is much greater than the volatility spillover effect from the U.S. market to the local market. Again, in the case of Korea Electric Power, the unexpected increase of the underlying stock volatility (in standard deviation) by 1 percent could cause the increase of the ADR volatility (in standard deviation) by 0.221 percent (i.e., square root of 0.049), while the unexpected increase of the ADR volatility by 1 percent could cause the increase of the underlying stock return only by 0.095 percent (i.e., square root of 0.009). The average estimated values of the volatility spillover coefficient, $\bar{\hat{\delta}}^A$, of the Asian, Oceanian, and European firms are 0.152, 0.104, and 0.153, respectively.

Another noteworthy point from Table 2 is that the coefficient estimates of the return spillover effect, $\hat{\phi}^A$, from the Japanese market to the U.S. market are greater by and large than those from the other Asian countries to the U.S. market. Similar results for the volatility spillover effect are also found. These results imply that the information from the Japanese market is more efficiently transmitted into the U.S. market and the Japanese market is more closely integrated with the U.S. market than are the other Asian firms.

Interestingly, the return and volatility spillover effect between the Oceanian markets and the US market is the weakest in any direction.

7 In most cases, the cross-correlation coefficients between the underlying daytime return ($R_{D,t}$) and the ADR overnight return ($R^A_{N,t}$) are greater than the cross-correlation coefficients between the ADR daytime return ($R^A_{D,t}$) and the underlying overnight return ($R_{N,t}$). In the case of TDK of Japan, for example, the correlation coefficient between $R_{D,t}$ and $R^A_{N,t}$ is 0.614, whereas that between $R^A_{D,t}$ and $R_{N,t}$ is 0.188. This indicates that information transmission from the daytime local market to the overnight US market is stronger than information transmission from the daytime US market to the overnight local market.

2. Comparison of the Information Transmission Before and After the Asian Financial Crisis

It would be interesting to examine the impact of the Asian financial crisis on the extent of the information transmission between the Asian markets and the U.S. market. In order to investigate this issue, we employ the previous model of equation (1) or (2) with some modifications as follows.
For the underlying stock,

$$R_{N,t}=\lambda_0+\lambda_1 R_{D,t-1}+\phi\hat{e}^A_{D,t-1}+\theta_1 h_{N,t}+\varepsilon_{N,t}-a_1\varepsilon_{N,t-1}+(\phi'-\phi)\hat{e}^A_{D,t-1}D_{1t}+(\phi''-\phi)\hat{e}^A_{D,t-1}D_{2t}$$
$$h_{N,t}=\alpha_0+\alpha_1\varepsilon^2_{N,t-1}+\beta_1 h_{N,t-1}+\gamma_1 S^-_{t-1}\varepsilon^2_{N,t-1}+\delta\hat{e}^{A\,2}_{D,t-1}+(\delta'-\delta)\hat{e}^{A\,2}_{D,t-1}D_{1t}+(\delta''-\delta)\hat{e}^{A\,2}_{D,t-1}D_{2t}$$

where

$D_{1t}=1$ if t is during the Asian financial crisis and 0 otherwise, and
$D_{2t}=1$ if t is after the Asian financial crisis and 0 otherwise.

For the ADR,

$$R^A_{N,t}=\lambda^A_0+\lambda^A_1 R^A_{D,t-1}+\phi^A\hat{e}_{D,t}+\theta^A_1 h^A_{N,t}+\varepsilon^A_{N,t}-a^A_1\varepsilon^A_{N,t-1}+(\phi^{A\prime}-\phi^A)\hat{e}_{D,t}D_{1t}+(\phi^{A\prime\prime}-\phi^A)\hat{e}_{D,t}D_{2t}$$
$$h^A_{N,t}=\alpha^A_0+\alpha^A_1\varepsilon^{A\,2}_{N,t-1}+\beta^A_1 h^A_{N,t-1}+\gamma^A_1 S^-_{t-1}\varepsilon^{A\,2}_{N,t-1}+\delta^A\hat{e}^2_{D,t}+(\delta^{A\prime}-\delta^A)\hat{e}^2_{D,t}D_{1t}+(\delta^{A\prime\prime}-\delta^A)\hat{e}^2_{D,t}D_{2t}$$

Note that the parameter without prime (such as ϕ or ϕ^A) represents the parameter before the Asian crisis, the parameter with a single prime (such as ϕ' or $\phi^{A\prime}$) represents the parameter during the Asian crisis, and the parameter with a double prime (such as ϕ'' or $\phi^{A\prime\prime}$) represents the parameter after the Asian crisis. Asian and Oceanian firms only are used to estimate the above models.

Table 3 shows the significant difference in the information transmission between before and after the Asian crisis. The coefficient $\phi''-\phi$ measures the difference in the unexpected return spillover effect from the ADR in the daytime U.S. market to its underlying stock in the overnight local market between after and before the Asian financial crisis. The positive value is interpreted as the greater effect of the unexpected return spillover after the Asian crisis than before the Asian crisis. Most (or all) companies in Korea and Japan have positively significant coefficient estimates at the significance level of one percent. The companies from Philippines have significant but negative coefficients, which indicates that the return spillover effect is declining after the crisis. On the other hand, all companies in New Zealand, China, Taiwan, and Hong Kong and most companies in Australia have insignificant coefficient estimates (three Australian companies have even significantly negative coefficient estimates). In fact, these countries had been less suffered from the Asian crisis than the other countries except for Japan.[8]

The coefficient $\delta''-\delta$ measures the difference in the volatility spillover effect from the ADR in the daytime U.S. market to its underlying stock in the overnight local market between after and before the Asian Crisis. Unlike the unexpected return spillover effect, in most Asian countries, the volatility spillover after the Asian crisis becomes more significant than before the Asian crisis. This evidence is consistent with that of Longin and Solnik (1995), who argues that international correlation or spillover effect tends to increase in periods of high stock

[8] Further investigation might be needed in the future to determine whether this phenomenon is a result of more integration with the U.S. market of the former markets, or whether the so-called Chinese Economic Area countries and Australasian countries are less economically dependent on the U.S. economy. For example, during the 1990s, the U.S. economy experienced a downward trend, while the Chinese economy has continued to grow.

market volatility, especially in the U.S. market.

The coefficient $\phi' - \phi$ ($\delta' - \delta$) measures the difference in the unexpected return (volatility) spillover effect from the ADR in the daytime U.S. market to its underlying stock in the overnight local market during the Asian financial crisis and before the Asian financial crisis. The estimates of the two above coefficients are positive and larger in magnitude in most companies, but statistically insignificant. The statistical insignificance might be due to a small sample size. Only four observations are used during the period of the Asian financial crisis.

Table 4 also reports the estimation results of the difference in the unexpected return and volatility spillover effect between after and before the Asian financial crisis in the reverse direction from the underlying stock in the daytime local market to its ADR in the overnight U.S. market. The estimation results generally have statistical significance similar to those in Table 3. Most Korean and Japanese companies have statistically significant positive estimates of the coefficient $\phi^{A''} - \phi^{A}$, which measures the difference in the unexpected return spillover effect from the underlying stock in the overnight local market to its ADR in the daytime U.S. market between after and before the Asian financial crisis. They also have positively significant estimates of the coefficient $\delta^{A''} - \delta^{A}$, which measures the difference in the volatility spillover effect between after and before the Asian financial crisis in the same direction as in $\phi^{A''} - \phi^{A}$. In other words, the two-way directional information transmission of return and volatility between the Korean and U.S. markets and between the Japanese and U.S. markets has been more efficiently intensified after the Asian financial crisis.

On the other hand, most of the companies in New Zealand, China, Taiwan, and Hong Kong and many companies in Australia have insignificant coefficient (or even negatively significant) estimates of $\phi^{A''} - \phi^{A}$. In other words, the Asian financial crisis has not significantly affected the extent of the unexpected return spillover in either direction between those countries and U.S. markets. It can be observed, however, that the volatility spillover in the two-way direction between those countries and U.S. markets has been generally intensified since the Asian financial crisis.

3. Relationship between Return-Volatility Spillover and Foreign Operations

If a local Asian firm is more exposed to foreign operations (in terms of sales and foxed asset investment), relevant news from U.S. markets regarding the firm's operation could be more informative than when the firm is less exposed. In this case, it would be expected that the reaction of U.S. investors leads to a reaction of the local investors. That is, the return-volatility spillover from the U.S. market to local market is expected. It would be interesting, therefore, to examine if there is a relation between the degree of the return-volatility spillover and the foreign operations. In order to do this, we cross-sectionally regress year by year the spillover coefficients (ϕ, ϕ^{A}, δ, δ^{A})estimated in the first-pass time-series GJR-M model of equations (1) and (2) on the firm specific variables, as in equation (5).

Table 5 presents the time-series averages of the coefficient estimates of equation (5). Overall, the more the foreign operations (in terms of sales and assets), the more the return information is transmitted from the U.S. market to the local market, but the less the return information is transmitted in the opposite direction. For example, the coefficient estimates on FS (foreign sales) are 0.002 (t-statistic of 4.57) and -7.7×10^{-4} (t-statistic of -2.08), respectively, when $\hat{\phi}$ and $\hat{\phi}^{A}$ are used as the dependent variable. However, this is not true for the volatility spillover. The more the foreign assets, the less the volatility information is transmitted in both directions. The coefficient estimates on FA are -0.001 (t-statistic of -5.12) and -0.001 (t-statistic of -7.38), respectively, when $\hat{\delta}$ and $\hat{\delta}^{A}$ are used as the dependent variable. The coefficient estimates on FS are also negative, but insignificant.

V. *Conclusions*

We use more refined statistical models to test for pricing information transmission between underlying stocks and ADRs of 114 firms (27 Asian firms, 13 Oceanian firms and 74 European firms). Using daily data from as early as 1990 to October 2002, we have found several interesting results. First, daytime returns on the underlying stocks are more volatile than their overnight returns, whereas overnight returns on the ADRs are more volatile than their daytime returns. The possible explanation is that the relevant firm-specific information more often arrives to the local daytime market and then immediately to the U.S. overnight market. This suggests that local daytime information is more influential on the pricing of the dually-traded stocks in the local and U.S. markets than U.S. daytime information.

Secondly, all sample firms' stocks are priced to reflect information from the local markets as well as from the U.S. market. However, the return and volatility spillover from the underlying stock in the daytime markets to its ADR in the overnight U.S. market is much stronger than the return and volatility spillover effect in the reverse direction from the U.S. market to the local markets.

Thirdly, in Korea and Japan, the Asian financial crisis has further intensified the information transmission in both directions from the local market to the U.S. market and from the U.S. market to the local market. That is, the extent of the return and volatility spillover effect between the Korea/Japan markets and the U.S. market becomes greater after the Asian financial crisis than before. On the other hand, most of the companies in New Zealand, China, Taiwan, and Hong Kong and many companies in Australia show insignificant change in the extent of the information transmission in either direction after the Asian financial crisis.

Fourthly, the more the foreign operations (in terms of sales and assets), the more the return spillover from the U.S. market to the local market, but the less the return spillover in the opposite direction. However, the more the foreign assets are, the less the volatility spillover occurs in both directions.

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Table 1. Estimates of the Parameters for the Asian Firms' Overnight ADR Return on the Underlying Stocks in the Model:

$$R_{N,t}=\lambda_0+\lambda_1 R_{D,t-1}+\phi\hat{e}^{A}_{D,t-1}+\theta_1 h_{N,t}+\varepsilon_{N,t}-a_1\varepsilon_{N,t-1} \text{ (Mean equation)}$$
$$h_{N,t}=\alpha_0+\alpha_1\varepsilon^2_{N,t-1}+\beta_1 h_{N,t-1}+\gamma_1 S^{-}_{t-1}\varepsilon^2_{N,t-1}+\delta\hat{e}^{A\,2}_{D,t-1} \text{ (Volatility equation)}$$

	Mean equation					Volatility equation				
	λ_0 ($\times 10^2$)	λ_1	ϕ	θ_1	a_1	α_0 ($\times 10^3$)	α_1	β_1	γ_1	δ
Korea:										
Korea Elec Power	0.026	−0.019	0.086*	2.224	0.015	0.000	0.003	0.978*	0.018*	0.009*
Korea Telecom	−0.144	0.016	0.254*	4.487	0.037	0.021*	0.241*	0.584*	0.016	0.105*
Posco	−0.066	0.046*	0.060*	2.592	0.083*	0.009*	0.070*	0.817*	0.031*	0.066*
SK Telecom	−0.331*	0.037*	0.140*	3.814*	0.059+	0.021*	0.060*	0.803*	0.041*	0.086*
Japan:										
Hitachi	−0.053	−0.043*	0.201*	2.773	0.060*	0.000	0.043*	0.894*	0.026+	0.102*
Honda	0.024	−0.075*	0.227*	2.069	0.061*	0.005*	0.075*	0.863*	0.020	0.062*
Ito Yokado	0.047	−0.019	0.110*	0.100	0.061*	0.004*	0.045*	0.887*	0.030*	0.064*
Kubota	0.024	−0.119*	0.198*	3.019	−0.024	0.003*	0.054*	0.897*	0.022+	0.165*
Kyocera	−0.000	−0.018	0.251*	1.325	0.052*	0.002*	0.086*	0.860*	0.043*	0.070*
Makita	0.040	−0.121*	0.062*	3.208	0.023	0.005*	0.047*	0.922*	−0.021*	0.016*
Matsushita	0.067	−0.022+	0.111*	0.678	0.080*	0.003*	0.054*	0.904*	0.005	0.033*
Mitsui	0.103*	−0.039*	0.114+	−1.481	0.102*	0.001*	0.059*	0.913*	0.034*	0.053*
NEC	0.036	−0.001	0.181*	0.435	0.096*	0.007*	0.042*	0.806*	0.096*	0.149*
Nissan	0.015	0.012	0.069*	2.391	0.052+	0.003*	0.025*	0.919*	0.081*	0.039*
NTT	0.067	0.031+	0.041+	−1.665	0.089*	0.004*	0.118*	0.837*	0.045*	0.014*
Pioneer	−0.027	−0.043*	0.055+	1.943	0.053*	0.001*	0.023*	0.913*	0.023*	0.044*
Sony	0.095*	−0.019	0.365*	−1.392	0.066*	0.002*	0.062*	0.854*	0.039*	0.137*
Sanyo	0.089	−0.027	0.054	0.549	0.105*	0.005*	0.058*	0.898*	0.016	0.043*
TDK	−0.019	0.021+	0.119*	1.365	0.031	0.002*	0.076*	0.874*	0.035*	0.085*
Hong Kong:										
APT Satellite	−0.413*	−0.000	0.101*	3.347	0.088*	0.088*	0.034	0.477*	0.069*	0.121*
Asia Satellite Tel	−0.023	−0.012*	0.123*	−1.651	0.065*	0.050*	0.582*	0.050*	1.869*	0.174*
HSBC HDG	−0.103	0.016	0.138*	4.550	0.002	0.002+	−0.027*	0.919*	0.109*	0.083*
China:										
Guangsheng Rail	0.022	−0.039*	0.145*	4.284	0.049	0.066*	0.131*	0.555*	−0.043	0.101*
Jilin Chem	−0.065	0.026*	0.062*	4.263+	0.144*	0.046*	0.086*	0.689*	0.077*	0.092*
Sinopec Shanghai	−0.043	−0.007	0.158*	2.931	0.027	0.016*	0.029*	0.751*	0.078*	0.153*
Taiwan:										
Macronix	0.660*	0.116*	0.119*	−9.202*	0.090*	0.017*	0.031*	0.876*	0.048*	0.024*
Taiwan Semicon	0.066	0.036	0.198*	−0.013	0.140*	0.028*	0.062*	0.791*	0.084*	0.022*
Philippine:										
Philippine Tel	−0.043	−0.015	0.437*	1.162	0.042+	0.023*	0.049*	0.568*	0.132*	0.136*
Australia:										
Amcor	0.029	−0.033*	0.030*	−0.130	0.087*	0.001*	0.040*	0.677*	0.200*	0.010*
Aus & NZ Bank	−0.127*	−0.024+	0.004	18.775*	0.038	0.002*	0.093*	0.892*	−0.025+	0.002
Ansell	−0.067	−0.083*	0.039*	5.071	0.092*	0.026*	0.085*	0.421*	0.237*	0.036*
Atlas Pacific	0.167+	−0.246*	0.076*	−1.571	−0.099*	0.002	−0.003	0.963*	0.085*	−0.001
BHP Billton	−0.008	0.052*	0.122*	1.854	0.076*	0.003*	0.093*	0.826*	−0.005	0.037*
Coles Myer	0.105*	−0.075*	0.021	1.156	0.004	0.007*	0.015	0.786*	0.193*	0.081*
Lihir Gold	0.106	−0.077*	0.387*	1.324	0.061+	0.077*	0.286*	0.424*	−0.100*	0.185*

	Mean equation					Volatility equation				
	λ_0 ($\times 10^2$)	λ_1	ϕ	θ_1	a_1	α_0 ($\times 10^3$)	α_1	β_1	γ_1	δ
News Corp	−0.027	0.059*	0.024	1.536	0.061*	0.018*	0.147*	0.777*	0.051*	0.018*
Orbital Engine	−0.270*	−0.084*	0.217*	9.492*	0.027	0.078*	0.089*	0.495*	0.035+	0.076*
Santos	−0.038	−0.003	0.002	11.950	0.123*	0.035*	0.135*	0.238*	0.072+	0.046*
Westpack Banking	−0.067*	−0.039*	0.103*	4.203	0.035	0.017*	0.213*	0.375*	0.066+	0.137*
New Zealand:										
Fletcher Challenge	0.101	−0.259*	0.251*	2.158	−0.037	0.007*	0.135*	0.730*	0.008	0.113*
Tel Corp of NZ	−0.007	−0.132*	0.248*	7.310	0.054	0.007*	0.169*	0.718*	−0.028	0.034*
Belgium:										
DELHAIZE	−0.022	−0.034	0.021	39.619*	0.062	0.000*	0.039	−0.863*	−0.007	0.056*
Finland:										
Instrumentarium	−0.013	−0.160*	0.096*	2.042*	0.532*	0.010*	0.479*	−0.000	4.044*	0.061*
Nokia	0.045	−0.181*	0.441*	−15.369	−0.037*	0.006*	−0.020*	0.804*	0.174*	0.039
Metso	−0.039	−0.152*	0.456	73.022*	−0.052*	0.003*	0.052	0.706*	−0.046	0.069*
Stora enso oyj	0.066	−0.111*	0.130+	−16.308	0.036	0.009*	−0.017	0.608*	−0.168*	0.275*
Upm-kymmene	0.040	−0.118*	0.023	−10.332	0.093	0.014*	0.189*	0.041	−0.074	0.277*
France:										
Alcatel	−0.034*	0.018	0.120*	3.270	−0.038	0.000	0.120*	0.687*	0.068*	0.187*
Alstom	−0.038*	−0.084	−0.020	19.114*	0.087*	0.002*	0.179*	0.742*	−0.025	0.079*
Business Objects	−0.065	−0.115*	0.295*	8.012+	−0.129*	0.004	0.115*	0.784*	0.041	0.045*
Dassault Aviation	−0.050	−0.219*	0.010	5.168	0.008	0.003*	0.005	0.866*	0.108*	0.013*
Equant	0.151*	−0.012	0.093*	−3.925	−0.062*	0.004*	−0.008*	0.862*	0.015	0.094*
France Telcom	−0.120*	−0.014	0.099*	9.889+	−0.075*	0.000	0.074*	0.852*	−0.026	0.078*
Gemplus Int	−0.084	−0.049*	−0.009	8.674	−0.069	0.005*	0.063	0.731*	0.049	0.040*
Havas	0.081	−0.048*	0.079+	3.207	−0.070	0.005*	0.056+	0.800*	0.054	0.058*
ILOG	−0.028	−0.060*	0.165*	5.454	0.003	0.152*	0.102*	0.161+	−0.057	0.174*
Infovista	0.015	−0.075*	0.159*	6.046	−0.125	0.025*	0.141*	0.610*	−0.064	0.123*
Lafarge	−0.067	−0.042+	−0.012	−31.645	−0.164*	0.000	0.059	0.893*	0.077	0.089
Rhodia	0.002	−0.050*	−0.078*	14.618*	0.124*	0.006*	0.189*	0.576*	−0.025	0.180*
Scor	0.025	−0.053*	0.044	−1.476	0.003	0.011*	0.413*	0.356*	−0.212*	0.457*
LVMH	0.054*	−0.059*	0.055*	−14.880+	0.002	0.001*	0.063*	0.843*	0.058*	0.017*
Total Fina elf sa	0.000	−0.049*	0.151*	3.393	0.041	0.000*	0.118*	0.797*	0.058*	0.047*
Germany:										
Allianz	0.067*	0.025	0.047	3.407	−0.061	0.000	0.238*	0.798*	−0.165*	0.043*
Basf	−0.008	0.028	−0.211	31.610*	0.069+	0.004*	0.306*	0.374*	−0.019	0.143*
Bayer	0.086*	0.096*	−0.195*	−0.923	0.054	0.008*	0.307*	0.149*	0.207*	0.256*
Deutsche Telekom	−0.026	−0.017	0.194*	8.914	−0.040	0.003*	0.052*	0.804*	0.100*	0.026*
Dialog Semicon	0.388*	−0.010	0.177*	−4.860*	−0.288*	0.021*	0.944*	0.674*	−0.924*	0.007
EON	−0.016	−0.029*	0.051*	9.015	0.009	0.000	0.173*	0.799*	−0.017	0.033*
Epcos	0.086+	0.007	0.050	1.019	−0.050	0.008*	0.317*	0.527*	−0.085	0.217*
Intershop Comms	−1.013*	−0.104*	0.526*	10.148*	0.070	0.308*	0.090	0.292*	0.313*	0.238*
Ixos Software	0.209*	0.057*	0.070*	2.984	0.005	0.007*	−0.012	0.664*	0.496*	0.054*
Schering	0.048	−0.007	−0.019	12.081	−0.028	0.002*	0.043+	0.629*	0.192*	0.091*
Siemens	0.033+	0.066*	−0.094*	0.393	−0.086*	0.001*	0.240*	0.640*	0.054	0.096*
Italy:										
Benetton	−0.057	0.055+	−0.013	5.699	0.013	0.001*	0.027	0.899*	0.009	0.035*
Luxotica	0.003	−0.077*	0.070	10.354	0.105+	0.005*	−0.004	0.644*	0.092*	0.163*
Ducati Motor	0.048	−0.044+	−0.020	9.111	0.025	0.003*	0.597*	0.597*	−0.167	0.041
Eni	−0.002	−0.073*	0.042	−17.470	−0.129*	0.001*	0.054+	0.799*	−0.043	0.055*
Fiat	0.012	−0.012	0.007	5.748	−0.024	0.000	0.045*	0.886*	0.144*	0.008
San paolo imi	−0.071+	−0.055*	0.029	15.945	−0.099+	0.003*	0.066	0.659*	0.077+	0.144*

	Mean equation					Volatility equation				
	λ_0 ($\times 10^2$)	λ_1	ϕ	θ_1	a_1	α_0 ($\times 10^3$)	α_1	β_1	γ_1	δ
Telecom Italia	−0.019	−0.053*	0.102*	7.422	−0.122*	0.008*	0.089	0.312*	0.382*	0.071*
Norway:										
PTL.GEO Service	0.035	0.028	0.384*	0.444	0.084	0.002	−0.058*	0.808*	−0.266*	0.275*
Spain:										
Repsol ypf	−0.011	−0.042*	0.126*	18.804	0.056+	0.004*	0.083*	0.492*	0.090*	0.090*
Sweden:										
Volvo	−0.108	−0.043	0.015	54.451	−0.015	0.002*	0.123*	0.806*	−0.069	0.015
Electrolux b	0.015	0.049+	−0.096	−4.860	−0.078	0.000	−0.003	0.910*	0.020	0.070*
Swedish Match	−0.074	−0.059*	0.082+	40.762	0.080	0.004*	0.062	0.847*	−0.079*	−0.029*
Switzerland:										
ABB LTD.R	−0.045	0.008	0.028	3.188	−0.043	0.036*	0.150*	0.237*	−0.136+	0.258*
ADECCO R	0.013	−0.001	0.034	7.251	−0.049+	0.007*	0.184*	0.431*	0.202*	0.113*
Logitech R	−0.022	−0.063*	0.054*	11.312*	0.021	0.003*	0.046*	0.675*	0.252*	0.071*
Novartis	0.021	−.0.020	0.125*	−17.025	−0.143*	0.000*	−0.001	0.728*	0.426*	0.056*
Serono “b”	−0.010	−0.030	0.174*	8.978	−0.007	0.010*	−0.010	0.606*	0.026	0.083*
Swisscom R	−0.017	−0.016	0.022	50.692*	−0.025	0.000*	0.104*	0.870*	−0.042*	0.014*
Syngenta	0.039	−0.033	0.104*	8.195	0.078	0.006*	0.203*	0.474*	0.097	0.009
UK:										
Barclay	0.021+	0.006	0.006	−3.566	0.009	0.000	0.065*	0.911*	−0.014	0.016*
British Airways	−0.012	−0.030*	0.105*	0.499	0.048+	0.000	0.029*	0.953*	0.007	0.012*
British Biotech	0.010	−0.005	0.173*	2.630	0.074*	0.007*	0.197*	0.715*	−0.154*	0.060*
Brit sky Bcast	−0.020	−0.012	0.087*	4.881	0.017	0.000*	0.030*	0.898*	0.091*	0.014*
Cadbury Sch	0.008	−0.046*	0.080*	9.669	0.017	0.000*	0.137*	0.839*	−0.025+	0.013*
Carlton Comms	−0.004	0.004	0.005	4.619	0.035	0.000	0.067*	0.912*	−0.007	0.015*
Danka Bus. Sys	−0.017	−0.013*	0.168*	−0.428	0.040	0.000	0.075*	0.668*	0.142*	0.060*
Imp Chm Inds	−0.000	−0.024+	0.115*	2.595	0.016	0.000*	0.073*	0.817*	−0.073*	0.202*
Scottish Power	0.007	−0.113*	0.097*	−0.761	−0.051	0.011*	0.228*	0.375*	−0.197*	0.138*
Shell Transport	0.027*	−0.029*	0.238*	−10.692	−0.048+	0.000*	0.071*	0.845*	−0.007	0.045*
Telewest Comms	0.030*	−0.034*	0.101*	3.447*	0.010	0.000*	−0.001	0.920*	0.097*	0.026*
Tomkins	0.048*	0.003	0.006	−12.254	0.049+	0.000	0.055*	0.933*	0.002	0.005*
Unilever	−0.012+	−0.021*	0.055*	12.750+	0.083*	0.000*	0.245*	0.733*	−0.043	0.028*
Vodafone	0.028+	−0.040*	0.286*	5.816	−0.034	0.001*	0.062*	0.762*	0.086*	0.068*
WPP	0.012	−0.046*	0.051*	−1.052	0.060*	0.000*	0.030*	0.824*	0.163*	0.059*
Amersham	0.020	−0.085*	0.012	6.440	−0.023	0.005*	0.017	0.767*	0.200*	0.039*
Amvescap	0.051*	−0.029*	0.014	−6.558	0.102*	0.000	0.049*	0.838*	0.231*	0.035*
Anglo American	−0.060	−0.044*	0.049	12.852	0.021	0.000	0.034+	0.851*	0.004	0.058*
ARM Holdings	0.034	−0.059*	0.167*	−0.687	−0.080+	0.002	0.200*	0.811*	0.073+	0.001
Astrazeneca	0.013	−0.095*	0.151*	−6.897	−0.020	0.000*	0.101*	0.861*	0.140*	0.005*
BG Group	0.054*	−0.058*	0.049*	−2.540	−0.021	0.000	0.061*	0.896*	−0.001	0.035*
Bookham Tech	−0.098	−0.118*	0.190*	0.378	−0.135*	0.141*	0.030	0.094	0.014	0.134*
British Energy	−0.061	−0.118*	0.127+	0.648	−0.103	0.023*	1.001*	0.127*	−0.766*	1.090*

* significant at 1% level + significant at 5% level

TABLE 2. ESTIMATES OF THE PARAMETERS FOR THE ASIAN FIRMS' OVERNIGHT UNDERLYING STOCK RETURN ON THE ADR IN THE MODEL:

$$R^A_{N,t}=\lambda^A_0+\lambda^A_1 R^A_{D,t-1}+\phi^A \hat{e}_{D,t}+\theta^A_1 h^A_{N,t}+\varepsilon^A_{N,t}-a^A_1\varepsilon^A_{N,t-1} \text{ (Mean equation)}$$
$$h^A_{N,t}=\alpha^A_0+\alpha^A_1\varepsilon^{A\,2}_{N,t-1}+\beta^A_1 h^A_{N,t-1}+\gamma^A_1 S^-_{t-1}\varepsilon^{A\,2}_{N,t-1}+\delta^A \hat{e}^2_{D,t} \text{ (Volatility equation)}$$

	λ^A_0 ($\times 10^2$)	λ^A_1	ϕ^A	θ^A_1	a^A_1	α^A_0 ($\times 10^3$)	α^A_1	β^A_1	γ^A_1	δ^A
Korea:										
Korea Elec Power	−0.072	−0.062*	0.385*	1.918	0.047	0.010*	0.075*	0.810*	0.074*	0.049*
Korea Telecom	−0.391*	−0.069*	0.564*	5.306	0.016	0.040*	0.070*	0.676*	0.051	0.183*
Posco	−0.130+	−0.032+	0.380*	2.414	0.079*	0.017	0.068*	0.700*	0.117*	0.153*
SK Telecom	−0.046	−0.016	0.473*	1.568	0.051	0.008*	0.073*	0.779*	0.084*	0.108*
Japan:										
Hitachi	−0.164*	−0.121*	0.625*	2.241	0.135*	0.001*	0.038*	0.852*	0.073*	0.071*
Honda	−0.062	−0.095*	0.618*	3.551	0.082*	0.006*	0.061*	0.810*	0.007	0.080*
Ito Yokado	−0.045	−0.273*	0.714*	−0.749	0.006	0.010*	0.016*	0.837*	0.079*	0.092*
Kubota	−0.101	−0.050	0.414*	1.358	0.016	0.055*	−0.011	0.573*	−0.003	0.200*
Kyocera	−0.088*	−0.086*	0.736*	1.862	0.078*	0.005*	0.022*	0.805*	0.058*	0.130*
Makita	−0.237*	−0.441*	0.469*	6.088*	−0.187*	0.007*	0.019*	0.908*	0.053*	0.051*
Matsushita	−0.137*	−0.204*	0.653*	−0.463	0.058*	0.008*	0.010	0.798*	0.123*	0.099*
Mitsui	−0.050	−0.042	0.335*	0.608	−0.043	0.005*	−0.022*	0.902*	0.027*	0.181*
NEC	−0.095	−0.208*	0.763*	1.512	0.055*	0.005*	0.030*	0.870*	0.087*	0.062*
Nissan	−0.049	−0.249*	0.599*	3.523	0.026	0.079*	0.014	0.544*	0.136*	0.179*
NTT	−0.054	−0.126*	0.578*	−1.251	0.062*	0.044*	0.048*	0.491*	0.067*	0.282*
Pioneer	−0.187*	−0.126*	0.453*	2.367	0.013*	0.049*	0.016+	0.616*	0.042*	0.240*
Sony	−0.065+	−0.048*	0.607*	0.702	0.094*	0.002*	0.027*	0.778*	0.125*	0.138*
Sanyo	−0.196	−0.237*	0.511*	2.887	−0.046	0.046*	0.009	0.754*	−0.021	0.293*
TDK	−0.083+	−0.013	0.540*	1.632	0.033	0.005*	−0.021*	0.841*	0.130*	0.100*
Hong Kong:										
APT Satellite	−0.120	−0.053*	0.225*	2.241	0.068+	0.069*	0.263*	0.496*	−0.034	0.146*
Asia Satellite Tel	−0.061	−0.066*	0.396*	1.127	0.037	0.058*	0.043	0.099*	−0.043	0.414*
HSBC HDG	−0.149	−0.280*	0.559*	1.131	−0.034	0.028*	−0.024	0.766*	0.175*	0.135*
China:										
Guangsheng Rail	−0.130+	−0.122*	0.471*	1.701	0.079*	0.036*	0.167*	0.470*	−0.079*	0.119*
Jilin Chem	−0.152+	−0.147*	0.466*	3.642*	0.093*	0.056*	0.158*	0.461*	−0.133*	0.153*
Sinopec Shanghai	0.011	−0.128*	0.504*	0.495	0.033	0.059*	0.005	0.289*	0.090*	0.174*
Taiwan:										
Macronix	0.037	−0.178*	0.499*	−0.228	0.028	0.000	−0.005	0.908*	0.083*	0.068*
Taiwan Semicon	0.417	0.008	0.440*	−5.509+	0.014	0.036*	0.022+	0.813*	0.096*	0.194*
Philippine:										
Philippine Tel	−0.008	0.019	0.380*	−3.254	0.093*	0.021*	0.004	0.571*	0.207*	0.172*
Australia:										
Amcor	−0.156*	−0.394*	0.636*	4.657	−0.103*	0.002*	0.027*	0.954*	0.027*	−0.007*
Aus & NZ Bank	−0.323*	−1.093*	0.0391	0.210*	0.056+	0.014*	0.068*	0.834*	0.070*	0.017
Ansell	−0.137*	−0.422*	0.564*	3.171*	−0.179*	0.002*	0.068*	0.911*	−0.005	0.027*
BHP Billton	0.013	−0.123*	0.685*	−4.086	0.010	0.010*	0.028*	0.806*	0.003	0.092*
Coles Myer	−0.008	−0.204*	0.494*	0.715	−0.039*	0.046*	−0.006*	0.497*	−0.017*	0.383*
Lihir Gold	0.127	−0.107*	0.550*	−3.333+	−0.058+	−0.001	0.012+	0.922*	0.035*	0.072*
News Corp	−0.193*	−1.023*	−0.004	2.570+	0.071*	0.008*	0.036*	0.924*	0.045*	0.006
Orbital Engine	−0.055	−0.154*	0.348*	−1.306	0.019	0.012*	0.136*	0.745*	−0.043*	0.065*

	λ_0^A ($\times 10^2$)	λ_1^A	ϕ^A	θ_1^A	a_1^A	α_0^A ($\times 10^3$)	α_1^A	β_1^A	γ_1^A	δ^A
Santos	0.054	−0.330*	0.465*	−1.759	−0.129*	0.043*	0.017	0.661*	0.074*	0.130*
Westpack Banking	0.037	−0.162*	0.604*	−3.522	0.013	0.023*	0.003	0.574*	0.140*	0.146*
New Zealand:										
Fletcher Challenge	−0.033	−0.117*	0.342*	−0.723	−0.006	0.005*	0.035*	0.882*	0.010	0.059*
Tel Corp of NZ	0.004	−0.066*	0.597*	−3.984	0.101*	0.020*	0.043*	0.498*	0.099	0.253*
Belgium:										
DELHAIZE	0.053	−0.164*	0.648*	3.440	0.054	0.006*	−0.010	0.373*	0.288*	0.263*
Finland:										
Instrumentarium	0.000	−0.497*	0.290+	3.141	−0.152+	0.006*	0.066	0.445*	0.066	1.286*
Nokia	0.072	0.047	0.530*	−9.776	−0.010	0.030*	0.083	0.555*	0.081	1.702*
Metso	−0.114+	−0.242*	0.517*	−49.675*	−0.076	0.005*	0.119*	0.632*	−0.114+	0.050*
Stora enso oyj	−0.008	−0.285*	0.596*	4.502	−0.060	0.022*	0.071	0.105	0.101	0.116*
Upm-kymmene	0.020*	−0.247*	0.615*	−37.169+	0.073+	0.003*	−0.086*	0.707*	0.019	0.120*
France:										
Alcatel	−0.125	−0.055*	0.448*	5.291*	0.067	0.001*	0.127*	0.733*	−0.043+	0.233*
Alstom	−0.055	−0.146*	0.514*	−8.509	0.021	0.017	0.150*	0.527*	−0.050	0.121*
Business Objects	−0.045*	−0.170*	0.392*	5.219	0.053	0.002	0.131*	0.728*	0.020*	0.111*
Dassault Aviation	−0.072	−0.197*	0.099*	−0.083	0.050+	0.001+	0.043	0.900*	0.065	0.028*
Equant	0.092	−0.077	0.608*	−8.336	0.015	0.014	0.015*	0.686*	0.048	0.105*
France Telecom	−0.099+	−0.064*	0.577+	1.443	0.045	0.001	0.041	0.872*	0.042	0.055*
Gemplus Int	−0.135*	−0.347*	0.416*	−0.031*	−0.069*	0.006	0.069	0.741*	0.057*	0.099
Havas	−0.286	0.676*	0.944*	11.101	−0.149*	0.002*	0.026*	0.884*	0.103*	0.029+
ILOG	0.075	0.166*	−0.273*	−1.374	0.000*	0.026	0.197*	0.444*	0.558	0.248
Infovista	0.017+	−0.350*	0.570*	0.102	−0.133*	0.031	0.137*	0.747*	0.075	0.025
Lafarge	−0.088	−0.210*	0.647*	−22.579	−0.013	0.002	0.104+	0.743*	−0.036	0.059*
Rhodia	−0.137	−0.032	0.551*	7.728	0.119*	0.030*	0.003	0.426*	0.073	0.123*
Scor	−0.036+	0.030	0.457*	2.681	0.075+	−0.001*	−0.007*	0.940*	0.093*	0.035*
LVMH	0.003	−0.262*	0.616*	−1.071	−0.005	0.001*	0.085*	0.825*	0.006	0.066*
Total fina elf	0.006*	−0.028	0.494*	−11.778	0.073*	0.001*	0.031*	0.845*	0.017	0.062*
Germany:										
Allianz	−0.149*	0.042	0.695*	3.864	−0.010	0.002+	0.140*	0.671*	0.111	0.140*
BASF	0.039	−0.319*	0.673*	−7.777	0.092*	0.010*	0.161*	0.426*	0.117+	0.168*
BAER	0.221*	−0.311*	0.640*	−18.469*	−0.135*	0.026*	0.043+	0.056+	3.419*	0.621*
Deutsche Telekom	0.007	−0.107*	0.609*	−1.205	−0.066*	0.001+	0.032	0.851*	0.064*	0.061*
Dialog Semicon	0.066	−0.341*	0.519*	−1.832	−0.145*	0.293*	0.267*	0.191	0.075	0.333*
EON	−0.103+	−0.308*	0.738*	8.822	−0.024	0.004*	0.064*	0.763*	−0.007	0.040*
Epcos	−0.250*	−0.043	0.766*	10.469+	0.082+	0.006*	0.035	0.801*	0.106*	0.073*
Intershop Comms	−1.072*	−0.101*	0.532*	10.646*	0.077	0.323*	0.038	0.301*	0.386*	0.208*
Ixos Sofrware	−0.126	−0.332*	0.606*	2.340-	0.135*	0.006	0.133*	0.771*	0.048	0.102*
Schering	−0.004	−0.230*	0.720*	−12.146	0.011	0.005*	−0.017	0.647*	0.168*	0.055*
Siemens	−0.035	0.000	0.806*	4.773	0.064	0.026*	0.124*	0.334*	0.188+	0.337*
Italy:										
Benetton	−0.083*	−0.115*	0.419*	6.497	−0.016	0.000	−0.026	0.852*	0.051*	0.056*
Luxottica	−0.065	−0.172*	0.284*	32.507+	0.062	0.008*	0.217*	0.247	−0.064*	0.137*
Ducati Motor	−0.314*	−0.091+	0.617*	34.322*	−0.056	0.006*	0.049	0.715*	−0.001	0.117*
ENI	0.058	−0.160*	0.513*	−21.252	0.028	0.004*	0.094+	0.641*	−0.052	0.107*
Fiat	−0.026	−0.129*	0.390*	−12.898	0.040	0.005*	0.030	0.385*	0.055	0.216*
San paolo imi	−0.203*	−0.173*	0.558*	9.992	0.000	0.003*	0.053	0.832*	0.092*	0.012
Telecom Italia	−0.106	−0.264*	0.561*	16.836	−0.069	0.008*	0.134*	0.556*	0.130*	0.117*
Norway:										
Ptl Geo Service	−0.198*	−0.074*	0.523*	−1.150*	0.448*	0.010*	0.642*	0.012	1.725*	0.437*

	λ_0^A ($\times 10^2$)	λ_1^A	ϕ^A	θ_1^A	a_1^A	α_0^A ($\times 10^3$)	α_1^A	β_1^A	γ_1^A	δ^A
Spain:										
Repsol Ypf	0.015	−0.133*	0.399*	−3.539	0.089*	0.003*	0.021	0.645*	0.078*	0.128*
Sweden:										
Volvo b	−0.080	−0.042	0.519*	24.293	0.092	0.002	−0.027*	0.893	0.091*	0.013
Electrolux b	−0.003	−0.260*	0.704*	10.429	0.086	0.001	0.013*	0.899	0.096*	0.029+
Swedish Match	0.046	−0.390*	0.604*	4.145	−0.206*	0.000	0.094*	0.897	−0.123+	0.029*
Switzerland:										
ABB LTD. R	−0.146	−0.043	0.571*	−7.541	0.125*	0.040*	−0.028	0.589*	0.035	0.163*
AECCO R	−0.020	−0.155*	0.646*	3.707	−0.037	0.007*	0.091*	0.479*	0.092*	0.158*
Logitech R	−0.104*	−0.190*	0.536*	17.244*	−0.045	0.012*	0.087*	0.622*	0.097*	0.076*
Novartis	−0.058	−0.208*	0.675*	−7.842	0.071	0.001+	0.096*	0.779*	0.030	0.057*
Serono b	−0.085	−0.039	0.580*	14.635	0.048	0.014*	−0.040	0.573*	0.188*	0.075*
Swisscom	−0.002	−0.275*	0.694*	2.996	−0.061	0.001*	0.008	0.794*	0.057+	0.067*
Syngenta	−0.117*	−0.249*	0.532*	−3.064	−0.005	0.001	−0.011	0.708*	0.046	0.100*
UK:										
Barclay	−0.015	−0.180*	0.656*	−6.554	−0.050*	0.001*	0.029*	0.886*	0.043*	0.044*
British Airways	0.001	−0.189*	0.647*	−11.918*	−0.080*	0.000	0.020	0.797*	0.084*	0.072*
British Biotech	−0.051	−0.419*	0.553*	−1.503	−0.208*	0.002	0.154*	0.846*	−0.047*	0.041*
Brit. Sky Bcast	0.002	−0.220*	0.608*	−2.478	−0.009	0.000*	0.003	0.819*	0.128*	0.064*
Cadbury Schweppes	−0.020	−0.245*	0.580*	−18.740+	−0.017	0.001*	0.013	0.726*	0.059*	0.082*
Carlton Comms	−0.018	−0.378*	0.666*	0.666	−0.110*	0.000*	0.111*	0.821*	−0.019	0.054*
Danka bus. Sys	0.010	−0.107*	0.197*	3.245	0.021	0.001*	0.178*	0.687*	−0.061*	0.050*
Imp. Chm. Inds	−0.014	−0.145*	0.542*	−6.190	0.027	0.001*	0.135*	0.574*	0.045+	0.164*
Scottish Power	−0.031	−0.324*	0.534*	12.838	−0.172*	0.005*	0.135*	0.478*	−0.086*	0.113*
Shell Transport	0.000	−0.050*	0.467*	−14.476	0.036	0.000*	0.040*	0.809*	0.074*	0.056*
Telewest Comms	0.001	−0.258*	0.553*	−1.051*	−0.067	0.000	0.063*	0.833*	0.067*	0.044*
Tomkins	0.009	−0.380*	0.521*	−18.167*	−0.116*	0.004*	0.018	0.700*	0.121*	0.074*
Unilever	−0.000	−0.094*	0.508*	−8.717	0.001	0.001*	0.061*	0.630*	0.099*	0.094*
Vodafone Group	0.005*	−0.051*	0.562*	−7.798	−0.014	0.000	0.023*	0.883*	0.044*	0.042*
WPP Group	−0.017	−0.262*	0.555*	7.839	−0.018	0.001*	0.067*	0.778*	0.067*	0.061*
Amersham	−0.039	−0.166*	0.417*	−5.881	−0.043	0.009*	0.028	0.301*	0.099*	0.167*
Amvescap	0.009	−0.093*	0.419*	−0.644	0.039	0.000	0.069*	0.674*	0.176*	0.114*
Anglo American	−0.059	−0.249*	0.611*	24.285	0.003	0.011*	0.076+	0.464*	0.051	0.098*
Arm Holdings	0.080	−0.083*	0.527*	0.580	0.035	0.059*	0.100*	0.173*	0.039	0.243*
Astrazeneca	−0.006	−0.088*	0.569*	0.334	0.038	0.002*	0.031*	0.649*	0.143*	0.086
BG Group	−0.012	−0.248*	0.539*	−15.968	−0.022	0.000	0.024*	0.785*	0.049	0.097*
Bookham Tech	0.024	−0.171*	0.359*	2.277	0.005*	0.046*	0.007	0.573	0.105	0.117*
British Energy	−0.185	−0.304*	0.434	−3.019	0.000	0.011*	0.077*	0.518*	0.045*	0.176*

* significant at 1% level + significant at 5% level

TABLE 3. ESTIMATES OF THE PARAMETERS FOR THE ASIAN FIRMS' OVERNIGHT ADR RETURN ON THE UNDERLYING STOCK IN THE MODEL WITH DUMMY VARIABLES OF THE ASIAN CRISIS:

$$R_{N,t}=\lambda_0+\lambda_1 R_{D,t-1}+\phi\hat{e}^A_{D,t-1}+\theta_1 h_{N,t}+\varepsilon_{N,t}-a_1\varepsilon_{N,t-1}+(\phi'-\phi)\hat{e}^A_{D,t-1}D_{1t}+(\phi''-\phi)\hat{e}^A_{D,t-1}D_{2t}$$

$$h_{N,t}=\alpha_0+\alpha_1\varepsilon^2_{N,t-1}+\beta_1 h_{N,t-1}+\gamma_1 S^-_{t-1}\varepsilon^2_{N,t-1}+\delta\hat{e}^{A\,2}_{D,t-1}+(\delta'-\delta)\hat{e}^{A\,2}_{D,t-1}D_{1t}+(\delta''-\delta)\hat{e}^{A\,2}_{D,t-1}D_{2t}$$

where

$D_{1t}=1$ if t is during the Asian financial crisis and 0 otherwise, and

$D_{2t}=1$ if t is after the Asian financial crisis and 0 otherwise.

	λ_0 ($\times 10^2$)	λ_1	θ_1	a_1	ϕ	$\phi'-\phi$	$\phi''-\phi$	α_0 ($\times 10^3$)	α_1	β_1	γ_1	δ	$\delta'-\delta$	$\delta''-\delta$
Korea:														
Korea Elec Power	−0.026	−0.031*	4.205+	0.007	0.041	0.055	0.114*	0.015*	0.042*	0.830*	0.026*	−0.000	0.078	0.075*
Posco	−0.028	0.052*	1.925	0.076*	−0.013	−1.807	0.143*	0.019*	0.040*	0.833*	−0.004	0.006	5.272+	0.077*
SK Telecom	−0.331*	0.046*	3.768+	0.068*	−0.026	0.800	0.223*	0.016*	0.040*	0.850*	0.022	0.061*	0.440	0.012
Japan:														
Hitachi	−0.054	−0.048*	2.994	0.054	0.072*	−0.319	0.344*	0.002*	0.053*	0.871*	0.013	0.078*	0.611	0.077*
Honda	0.077	−0.069*	−0.853	0.060*	0.194*	0.815*	0.074	0.006*	0.066*	0.855*	0.015	0.046*	−1.064*	0.082*
Ito Yokado	0.052	−0.018	0.152	0.058*	0.009	3.249	0.148*	0.005*	0.045*	0.886*	0.020+	0.008	1.581	0.063*
Kubota	0.031	−0.120*	2.590	−0.031	−0.001	1.033	0.256*	0.004*	0.027*	0.927*	0.016+	0.005	20.039*	0.152*
Kyocera	0.003	−0.005	1.217	0.056*	0.115*	3.573	0.315*	0.003*	0.070*	0.879*	0.020	0.047*	19.089	0.034+
Makita	0.046	−0.121*	2.825	0.024	0.048	1.058	0.017	0.005*	0.045*	0.920*	−0.022*	0.012*	1.979+	0.004
Matsushita	0.073	−0.025*	0.717	0.081*	−0.012	16.410	0.231*	0.003*	0.061*	0.895*	−0.005	0.012	69.826+	0.028*
Mitsui	0.108*	−0.042*	−1.497	0.103*	−0.048	−6.277	0.255*	0.002*	0.049*	0.914*	0.022	−0.040+	24.296	0.127*
NEC	0.036	−0.002	0.437	0.089*	0.043	1.660	0.285*	0.008*	0.042*	0.812*	0.082*	0.101*	0.100	0.057*
Nissan	0.007	−0.012	2.912	0.042	−0.033	−0.091	0.260*	0.000	0.029*	0.903*	0.072*	0.024*	0.209	0.035*
NTT	0.043	0.023	−0.334	0.088*	−0.069*	0.213	0.257*	0.010*	0.125*	0.777*	0.035	−0.000	0.509	0.068*
Pioneer	0.034	−0.048*	0.001	0.047*	0.014	2.693	0.083	0.018*	0.018*	0.856*	0.024*	0.022*	−0.093	0.111*
Sony	0.101	−0.013	−2.186	0.069*	0.173*	0.643	0.444*	0.002*	0.061*	0.854*	0.041*	0.111*	0.210	0.028
Sanyo	0.096	−0.029+	0.443	0.106*	−0.351*	−0.948	0.439*	0.005*	0.055*	0.902*	0.017	0.003	1.808	0.036
TDK	−0.021	0.022+	1.274	0.037	0.063	−0.076	0.157*	0.006*	0.075*	0.827*	0.049*	0.072*	6.613	0.176*
Hong Kong:														
APT Satellite	−0.400*	0.007	2.887	0.090*	0.201*	−0.390	−0.113	0.098*	0.030	0.436*	0.062*	0.043*	−0.239	0.110*
Asia Satellite Tel	−0.035	−0.024*	0.028	0.055*	0.170*	2.017	−0.048	0.056*	0.275*	0.061*	0.307*	−0.005	5.889	0.318*

China:														
Guangshen Rail	−0.016	−0.029*	5.065	0.054	0.101	−0.293	0.046	0.089*	0.084*	0.566*	−0.009	0.024	−0.937	0.041
Jilin Chem	−0.062	0.022*	3.982	0.137*	0.129*	1.231	−0.092	0.045*	0.095*	0.709*	0.053*	0.046*	1.865	0.036*
Sinopec Shanghai	−0.045	−0.011	2.758	0.032	0.182*	1.281	−0.047	0.021*	0.036*	0.723*	0.102*	0.125*	0.788	0.035*
Taiwan:														
Macronix	0.697*	0.120*	−9.815*	0.093*	0.013	−0.090	0.117	0.016*	0.025*	0.888*	0.048*	0.044*	0.178	−0.023*
Philippine:														
Philippine Tel	−0.034	−0.020*	1.586	0.049+	0.590*	1.513	−0.275*	0.025*	0.052*	0.571*	0.100*	0.060*	2.488	0.100*
Australia:														
Amcor	0.104*	−0.046*	−13.468*	0.065*	−0.038+	−1.261	0.115*	0.011*	0.003	0.736*	0.111*	−0.018*	2.215	0.033*
Aus & NZ Bank	−0.101*	−0.035*	16.152*	0.042	0.054	−4.642*	−0.065	0.002*	0.108*	0.873*	−0.028+	0.033*	4.767	−0.029*
Ansell	0.013	−0.078*	−2.881	0.082*	0.088*	1.739*	−0.081*	0.003	0.032*	0.880*	0.061*	0.012*	0.255*	−0.006*
Atlas Pacific	0.195+	−0.233*	−1.866	−0.096*	0.039	−22.255*	0.053	0.001	−0.004+	0.973*	0.061*	0.002	48.437*	−0.003
BHP Billiton	0.000	0.049*	1.015	0.075*	0.090	0.717	0.056	0.003*	0.096*	0.813*	−0.015	0.031*	1.175	0.010
Coles Myer	0.088*	−0.070*	3.641	0.024	−0.033	5.293	0.094	0.009*	0.014	0.765*	0.120*	0.023*	81.082	0.149*
Lihir Gold	0.133+	−0.066*	0.525	0.046	0.502*	−0.154	−0.150*	0.060*	0.247*	0.543*	−0.138*	−0.066*	10.218	0.209*
News Corp	0.028	0.059*	−0.345	0.070*	0.023	1.496	−0.011	0.007*	0.083*	0.868*	0.023*	0.002	1.930	0.086*
Orbital Engine	−0.285*	−0.089*	9.808*	0.027	0.232*	0.023	−0.027	0.084*	0.075*	0.479*	0.035+	0.053*	0.017	0.048*
Santos	−0.108	0.003	25.531	0.103*	−0.048	8.749*	0.058	0.028*	0.119*	0.388*	−0.059	0.003	5.744	0.048*
Westpack Banking	−0.058	−0.041*	3.694	0.037	0.168*	3.848*	−0.154*	0.014*	0.203*	0.457*	0.020	0.118*	9.539	−0.039*
New Zealand:														
Fletcher Challenge	0.118+	−0.258*	2.129	−0.041	0.193*	2.224	0.071	0.011*	0.141*	0.732*	−0.045	0.045*	17.353	0.068*
Tel Corp of NZ	−0.018	−0.132*	10.331	0.040	0.293*	3.543*	−0.044	0.004*	0.122*	0.801*	−0.035	0.039	2.002	−0.016

* significant at 1% level
+ significant at 5% level

TABLE 4. ESTIMATES OF THE PARAMETERS FOR THE ASIAN FIRMS' OVERNIGHT UNDERLYING STOCK RETURN ON THE ADR IN THE MODEL WITH DUMMY VARIABLES OF THE ASIAN CRISIS:

$$R^A_{N,t}=\lambda^A_0+\lambda^A_1 R^A_{D,t-1}+\phi^A \hat{e}_{D,t}+\theta^A_1 h^A_{N,t}+\varepsilon^A_{N,t}-a^A_1 \varepsilon^A_{N,t-1}+(\phi^{A\prime}-\phi^A)\hat{e}_{D,t}D_{1t}(\phi^{A\prime\prime}-\phi^A)\hat{e}_{D,t}D_{2t}$$

$$h^A_{N,t}=\alpha^A_0+\alpha^A_1 \varepsilon^{A\,2}_{N,t-1}+\beta^A_1 h^A_{N,t-1}+\gamma^A_1 S^-_{t-1}\varepsilon^{A\,2}_{N,t-1}+\delta^A \hat{e}^2_{D,t}+(\delta^{A\prime}-\delta^A)\hat{e}^2_{D,t}D_{1t}+(\delta^{A\prime\prime}-\delta^A)\hat{e}^2_{D,t}D_{2t}$$

where

$D_{1t}=1$ if t is during the Asian financial crisis and 0 otherwise, and

$D_{2t}=1$ if t is after the Asian financial crisis and 0 otherwise.

	λ^A_0 ($\times 10^2$)	λ^A_1	θ^A_1	a^A_1	ϕ^A	$\phi^{A\prime}-\phi^A$	$\phi^{A\prime\prime}-\phi^A$	α^A_0 ($\times 10^3$)	α^A_1	β^A_1	γ^A_1	δ^A	$\delta^{A\prime}-\delta^A$	$\delta^{A\prime\prime}-\delta^A$
Korea:														
Korea Elec Power	−0.049	−0.064*	1.253+	0.052+	0.222*	1.260	0.256*	0.016*	0.057*	0.798*	0.078*	0.005	2.654	0.064*
Posco	−0.145*	−0.024	2.712	0.081*	0.329*	6.492	0.074	0.029*	0.031*	0.657*	0.123	0.067*	31.213+	0.170*
SK Telecom	−0.030	−0.015	1.472	0.044	0.330*	1.844	0.200*	0.019*	0.073*	0.763*	0.047	0.046*	6.550	0.089*
Japan:														
Hitachi	−0.150*	−0.111*	1.272	0.140*	0.525*	−0.577	0.254*	0.004*	0.042*	0.838*	0.064*	0.051*	1.824	0.037*
Honda	−0.063	−0.098*	3.702	0.091*	0.554*	0.160	0.161*	0.008*	0.054*	0.784*	0.011	0.072*	1.157	0.050*
Ito Yokado	−0.043	−0.283*	−0.789	−0.004	0.637*	−1.039	0.157*	0.015*	0.019*	0.800*	0.078*	0.096*	−0.102	0.027+
Kubota	−0.114	−0.040	1.610	−0.001	0.089	0.229	0.416*	0.047*	−0.006	0.608*	−0.010	0.145	0.223	0.048*
Kyocera	−0.093*	−0.083*	2.088	0.083*	0.609*	−0.618	0.277*	0.005*	0.021*	0.804*	0.054*	0.131*	0.024	−0.003
Makita	−0.245*	−0.449*	6.424*	−0.189*	0.514*	−0.727	−0.108*	0.006*	0.018*	0.918*	0.050*	0.042*	0.303	0.001
Matsushita	−0.138	−0.199*	−0.075	0.064*	0.567	−1.913	0.204*	0.017*	0.008	0.685*	0.137	0.114*	1.688	0.095*
Mitsui	−0.006	−0.056	−0.555	−0.036	0.192*	−2.266	0.179+	0.010*	−0.020*	0.878*	0.014	0.130*	0.591	0.091*
NEC	−0.093	−0.206*	1.338	0.053*	0.734*	−1.054	0.062	0.009*	0.029*	0.839*	0.088*	0.063*	0.656	0.046*
Nissan	0.039	−0.236*	1.510	0.031	0.778*	−0.330	−0.248*	0.005*	−0.002	0.927*	0.088*	0.038*	−0.154	−0.018*
NTT	−0.044	−0.130*	−1.122	0.057+	0.308*	−0.367	0.387*	0.052*	0.034+	0.477*	0.058*	0.155*	1.482	0.139*
Pioneer	−0.179	−0.133*	2.170	0.023	0.352*	2.216+	0.236*	0.044*	−0.006	0.646*	0.063*	0.185*	−0.072	0.078*
Sony	−0.054+	−0.046*	−0.250	0.090*	0.501*	0.204	0.302*	0.004*	0.018+	0.758*	0.124*	0.108*	0.836	0.096*
Sanyo	−0.157	−0.243*	2.120	−0.046	0.323*	−0.930	0.262*	0.074*	0.006	0.665*	−0.022	0.189*	0.523	0.215*
TDK	−0.069	−0.018	0.920	0.033	0.465*	−0.589	0.183*	0.008*	−0.023*	0.813*	0.129*	0.100*	0.579	0.036*
Hong Kong:														
APT Satellite	−0.123	−0.050*	2.320	0.050	0.102*	0.992	0.124	0.099*	0.239*	0.386*	0.031	0.166*	0.010	0.019
Asia Satellite Tel	−0.058	−0.065*	1.018	0.035	0.418*	0.686	−0.028	0.060*	0.037	0.095*	−0.038	0.208*	1.013	0.233*

China:														
Guangshen Rail	−0.128^{+}	−0.111*	1.531	0.081*	0.420*	0.872	0.063	0.045	0.145*	0.421*	−0.079*	0.079*	0.676	0.070*
Jilin Chem	−0.143^{+}	−0.147*	3.463*	0.081*	0.426*	1.039	0.059	0.057*	0.253*	0.428*	−0.196*	0.113	1.012	0.052*
Sinopec Shanghai	0.018	−0.134*	0.355	0.034	0.474*	0.389	0.042	0.059*	0.010	0.293*	0.090*	0.163*	1.043	0.016
Taiwan:														
Macronix	0.009	−0.179*	0.196	0.027	0.523	−1.552	−0.023	0.005	−0.010	0.878*	0.096*	0.062*	2.120	0.040
Philippine:														
Philippine Tel	0.021	0.020	−5.466*	0.097*	0.315*	0.710	0.103*	0.026*	0.002	0.546*	0.174*	0.089*	0.407	0.137*
Australia:														
Amcor	0.133*	−0.389*	−3.417	−0.108*	0.617*	0.339	0.025	0.003*	0.032*	0.913*	0.024^{+}	0.039*	0.602*	−0.004
Aus & NZ Bank	−0.327*	−1.099*	10.333*	0.056^{+}	0.075	−0.288	−0.047	0.016*	0.068*	0.826*	0.072*	0.008	0.167	0.014
Ansell	−0.135*	−0.430*	3.107*	−0.186*	0.635*	0.884^{+}	−0.182*	0.006*	0.067*	0.896*	−0.007	0.011	0.722	0.037*
Atlas Pacific	0.258	−0.225*	−1.016	−0.103*	0.300*	−0.265	0.120	0.003	0.025*	0.964*	−0.017*	0.064*	0.050	−0.030*
BHP Billiton	0.003	−0.124*	−3.263	0.008	0.753*	0.017	−0.103^{+}	0.010*	0.031*	0.814*	−0.004	0.088*	0.185	−0.003
Coles Myer	−0.013	−0.214*	1.344	−0.044*	0.376*	−0.472	0.258*	0.041*	−0.005	0.548*	−0.020*	0.270*	5.891	0.080*
Lihir Gold	0.109	−0.126*	−2.736^{+}	−0.079*	0.702*	−1.629	−0.223*	0.010*	0.020*	0.881*	0.019^{+}	0.041*	0.629*	0.082*
News Corp	−0.177*	−1.016*	2.274	0.073*	−0.003	0.154	0.012	0.004*	0.024*	0.941*	0.042*	0.021*	−1.408*	−0.009
Orbital Engine	−0.107*	−0.152*	−0.100*	0.023	0.289*	−0.092	0.114	0.033*	0.152*	0.633*	−0.062^{+}	0.039*	0.013	0.104*
Santos	0.114	−0.336	−4.463	−0.132*	0.574	−0.937	−0.146*	0.048*	0.028	0.642*	0.023	0.060^{+}	3.596	0.085*
Westpack Bank	0.043	−0.162*	−3.738	0.013	0.631*	−2.093	−0.056	0.017*	−0.008	0.678*	0.098*	0.123*	4.625^{+}	−0.015*
New Zealand:														
Fletcher Challenge	−0.021	−0.115*	−0.951	−0.009	0.461*	0.249*	−0.150*	0.007*	0.032*	0.893*	−0.005	0.016	−0.030	0.043*
Tel Corp of NZ	0.023	−0.066*	−5.551	0.093*	0.636*	0.119	−0.037	0.027*	0.052*	0.424*	0.044	0.032	3.988	0.250*

* significant at 1% level

$^{+}$ significant at 5% level

TABLE 5. TIME-SERIES AVERAGES OF THE COEFFICIENT ESTIMATES IN THE CROSS-SECTIONAL REGRESSION MODEL OF THE INFORMATION TRANSMISSION COEFFICIENT ESTIMATES ON THE FIRM-SPECIFIC VARIABLES

Explanatory variables \ Dependent variable	Information transmission (IT) coefficient estimated in the first-pass time-series GJR(1,1)-M model			
	$\hat{\phi}_{it}^{A}$	$\hat{\phi}_{it}$	$\hat{\delta}_{it}^{A}$	$\hat{\delta}_{it}$
FA	−0.003**	-2.2×10^{-4}	−0.001**	−0.001**
	(−4.52)	(0.94)	(−7.38)	(−5.12)
DFA	−0.041**	−0.014	0.001*	−0.042**
	(−2.91)	(−0.03)	(2.32)	(−2.46)
FS	-7.7×10^{-4}**	0.002**	-1.9×10^{-4}	-4.4×10^{-4}
	(−2.08)	(4.57)	(−0.56)	(−1.24)
DFS	−0.079**	0.03**	0.013**	−0.011
	(−4.50)	(8.63)	(2.95)	(−1.15)
MB	−0.006*	0.001**	−0.002	−0.004**
	(−2.22)	(3.02)	(−1.27)	(−2.75)
DMB	−0.067*	0.008**	−0.097**	−0.058
	(−2.20)	(2.71)	(−2.71)	(−1.31)
MV	0.029**	−0.013**	0.003**	−0.006**
	(14.95)	(−8.84)	(2.97)	(−4.53)
$\hat{\beta}$	0.004**	−0.003	0.029**	0.020**
	(3.72)	(−0.42)	(11.65)	(16.07)

** significant at 1% level * significant at 5% level

Note: FA_{it} = foreign assets of firm i at year t divided by its total assets if the data is available and 0 otherwise
DFA_{it} = dummy variable; 0 if FA_{it} data is available and 1 otherwise
FS_{it} = foreign sales of firm i at year t divided by its total assets if the data is available and 0 otherwise
DFS_{it} = dummy variable; 0 if FS_{it} data is available and 1 otherwise
MB_{it} = market-to-book equity ratio of firm i at year t if the data is available and 0 otherwise
DMB_{it} = dummy variable; 0 if MB_{it} data is available and 1 otherwise
MV_{it} = log(market capitalization) of firm i at year t
$\hat{\beta}_{it}$ = Scholes-Williams(1977) beta estimate of firm i at year t
N_t = number of firms at year t